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**Type of Organization:** College or University

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**Project Title:** Reduction of Cadmium Emissions From Chicago Area Facilities

**Project Category:** Pollution Prevention and Reduction - BNS

**Rank by Organization (if applicable):** 1

**Total Funding Requested (\$):** 155,112 **Project Duration:** 2 Years

**Abstract:**

Water pollution resulting from industrial processes that release cadmium to the environment has been a source of concern to Great Lakes interests for many years. While some successful cases of pollution prevention (P2) implementation to reduce cadmium emissions have been documented, P2 continues to diffuse relatively slowly into many facilities that engage in metal finishing activities. Twelve metal finishing facilities currently plate parts with cadmium in the Greater Chicago area and most of them have yet to implement significant pollution prevention technology improvements.

The Illinois Waste Management and Research Center (WMRC) has developed technical assistance strategies that substantially improve the diffusion of innovative P2 technologies. This model provides mechanisms that address the deficiencies that are common in other P2 technical assistance models. It includes a sequential process of identifying best practices and executing brief demonstrations and extended pilot trials of the practices and technologies that provide the site-specific information required to influence companies decisions to adopt.

In this project, WMRC will work in cooperation with the Chicago Metal Finishers Institute (CMFI), the Department of Commerce and Community Affairs (DCCA), and the Metropolitan Water Reclamation District of Greater Chicago (MWRDGC) and the Illinois Environmental Protection Agency (IEPA) to use the ADOP2T model to diffuse technologies that will reduce cadmium emissions form Chicago metal finishing operations. WMRC project engineers will develop and execute pilot projects in 4 "mentor" metal finishing operations that represent the "opinion leaders" in this sector. These projects will confirm the technical and economic efficiency of specific pollution prevention technologies on a site-specific basis. These sites will be made available for demonstrations for other cadmium plating facilities interested in adopting the technologies.

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**Geographic Areas Affected by the Project****States:**

<input checked="" type="checkbox"/> Illinois	<input checked="" type="checkbox"/> New York
<input checked="" type="checkbox"/> Indiana	<input checked="" type="checkbox"/> Pennsylvania
<input checked="" type="checkbox"/> Michigan	<input checked="" type="checkbox"/> Wisconsin
<input checked="" type="checkbox"/> Minnesota	<input checked="" type="checkbox"/> Ohio

**Lakes:**

<input type="checkbox"/> Superior	<input type="checkbox"/> Erie
<input type="checkbox"/> Huron	<input type="checkbox"/> Ontario
<input type="checkbox"/> Michigan	<input checked="" type="checkbox"/> All Lakes

**Geographic Initiatives:**

<input checked="" type="checkbox"/> Greater Chicago	<input type="checkbox"/> NE Ohio	<input type="checkbox"/> NW Indiana	<input type="checkbox"/> SE Michigan	<input type="checkbox"/> Lake St. Clair
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**Primary Affected Area of Concern:** All AOCs**Other Affected Areas of Concern:**

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***For Habitat Projects Only:*****Primary Affected Biodiversity Investment Area:** Not Applicable**Other Affected Biodiversity Investment Areas:**

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**Problem Statement:**

Cadmium and cadmium compounds have long been identified as a human carcinogen. Releases of cadmium to surface and ground water include discharges from industrial facilities and sewage treatment plants and leaching from landfills or soil. In the Great Lakes region, hundreds of metal finishing facilities continue to engage in plating processes that use cadmium. Currently, 12 metal finishers in the Chicago area alone currently engage in plating processes that use cadmium compounds. Therefore, an effective strategy for reducing cadmium discharges to water resources is warranted.

Most individuals involved in the diffusion of innovative pollution prevention (P2) strategies would agree that while many successful cases of P2 adoption have been documented, P2 continues to diffuse relatively slowly across most industrial sectors (Lindsey, 1998). This phenomenon is particularly troublesome given the obvious advantages P2 offers over other environmental management strategies with respect to cost reduction, improved efficiency, improved compliance, waste reduction, environmental impact, etc. For example, technologies such as reverse osmosis, ion exchange, conductivity controls and evaporators have proven to be cost-effective technologies for reducing waste and improving efficiency in a variety of metal finishing applications. However, according to Cushnie (1994), these technologies and a variety of others, have achieved limited (<10%) penetration into metal finishing shops. The vast majority of these operations have not yet adopted many of the innovative pollution prevention technologies that are commercially available to them.

In 1995, the U.S. EPA established a "Common Sense Initiative" in the metal finishing sector to promote "cleaner, cheaper, and smarter" environmental performance using a non-adversarial, stakeholder consensus process to test innovative ideas and approaches (EPA, 1997). This initiative includes a set of voluntary goals associated with reductions in water and energy usage, and improved transfer efficiency of raw materials to product. To date, relatively few metal finishers have volunteered to participate in this program because: 1) government is not offering adequate incentives for their participation, and 2) the technical and financial means for achieving these goals are not readily available.

Research recently conducted by the Illinois Waste Management and Research Center (WMRC) suggests that providing "awareness" information (i.e., fact sheets, case studies, databases, and Internet resources) alone regarding pollution prevention innovations is inadequate with respect to encouraging adoption (Lindsey, 1999). Potential adopters of P2 technologies must address compatibility/complexity issues regarding "how-to" implement the technologies within individual facilities (Lindsey, 1998). Conducting effective demonstrations and extended pilot trials of P2 technologies have proven to be effective methods for encouraging companies to adopt innovative P2 technologies (Lindsey, 2000).

This project will utilize strategies that are specifically designed to address market failure associated with the diffusion of P2 technologies. Implementation assistance associated with conveying "how-to" knowledge to potential technology adopters is frequently lacking. Vendors do not usually provide the necessary assistance because: 1) they lack the technical resources in-house to adequately evaluate the technology on a pilot basis, 2) they are perceived by their customers to be biased and 3) pilot evaluations of the technologies tend to be very costly. Vendors try to avoid incurring the cost of extensive technical assistance because they can't be sure their customers will adopt the technology even after it has been successfully demonstrated. End users try to avoid incurring the cost of extensive technical assistance

because they are not sure if the innovation will actually perform at levels that will support vendor claims. Consultants are not certain that many of the innovative technologies will perform according to manufacturer's specifications, therefore, they tend to fall back on "time tested" pollution control technologies. The types of market failure described above are common to many innovative technologies. This project will attempt to address this market failure such that the diffusion of innovative P2 technologies can be expedited.

**Proposed Work Outcome:**

This project will be conducted in 7 basic steps as described below.

- 1) Conduct detailed assessments of cadmium related processes at various metal finishing shops to identify opportunities for innovative P2 practices and technologies
- 2) Evaluate Opportunities and Develop Testing Protocols for innovative P2 technology evaluations
- 3) Conduct pilot trials at mentor facilities of unproven technologies, identify and overcome barriers associated with their adoption
- 4) Conduct demonstrations of proven innovative technologies for various metal finishing interests
- 5) Develop case studies describing the pilot trials and distribute them to a variety of metal finishers
- 6) Train Consultants and Vendors regarding protocols for pilot trials
- 7) Provide implementation assistance regarding technical and economic issues with respect to technology adoption

A detailed description of precisely how these steps will be executed is provided below.

**Step 1: Conduct Detailed Assessments**

WMRC personnel will perform detailed assessments of the facilities to identify 1) innovative practices already in use and 2) opportunities for implementing additional innovative P2 practices that will reduce cadmium emissions. These assessments will help determine the variety and extent of the metal finishing and waste management operations. The shops will also be surveyed to determine their rates of water usage, waste generation and disposal, wastewater treatment practices, cleaning chemical usage and opportunities for incorporating pollution prevention technologies into their processes.

**Step 2: Evaluate Opportunities and Develop Testing Protocols**

The results of site visits and assessments will be combined with information collected from the focus group and used to identify test sites and develop scopes of work for innovative technology pilot trials. For each individual pilot trial undertaken in this effort, all aspects of the project design, including sample collection through data analysis, will be considered and discussed with WMRC quality assurance personnel prior to project start-up. The Principal Investigators will ensure that subcontractors performing work on this project will adhere to appropriate quality assurance procedures. A project quality assurance plan will be developed prior to initiation of each pilot trial.

**Step 3: Conduct Pilot Trials at Mentor Facilities**

Eight project ideas were formulated through meetings with the focus group that could provide the "how-to" information required to solve the most pressing pollution problems experienced by the Chicago metal finishers. Several of the 4 mentor facilities will probably request multiple projects be conducted at their facilities. Therefore, for the purposes of this project, approximately 10 pilot trials of innovative technologies will be conducted at metal finishing sites during this project. Opinion Leader facilities participating in this project have agreed to let their facilities serve as "Mentor" demonstration sites after they permanently install the technologies. The pilot trials to be undertaken in this project are briefly summarized below.

A. Waste Reduction and Reuse Trials - The processes that generate cadmium contaminated wastewater at these facilities will be examined to identify opportunities for segregation, recovery and reuse. This project will examine the analytical data collected to evaluate the quality of the treated wastewater generated. Determinations will be made with respect to which wastewater sources are of sufficient quality for reuse and which sources would require cadmium reduction prior to reuse. Specific technologies to be investigated in these trials will include:

- Reverse osmosis and evaporation technologies will be evaluated for removing cadmium from the rinse waters for reuse.
- Alternative barrel designs will also be evaluated for their ability to reduce cadmium dragout.

B. Aqueous Cleaners Recycling Trials - Most metal finishers utilize aqueous cleaning chemicals to clean parts prior to metal finishing operations. The chemical nature of aqueous cleaning chemicals tends to tie up cadmium and other metals. When these cleaners become saturated with contaminants they are discharged to wastewater treatment operations where they can be difficult to treat. Additionally, valuable cleaning chemicals are wasted as a result of this costly process. This project will evaluate ultrafiltration/microfiltration technologies for their capabilities to remove contaminants from the cleaners and extend their useful life.

C. Conductivity Control Trials - Many metal finishing shops have a difficult time managing rinse water flow through plating lines. Large quantities of water are frequently wasted on unattended lines because operators fail to shut down or reduce water flow when lines are not in use. Utilization of valves activated by conductivity probes have reportedly been used in

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some applications to greatly reduce rinse water usage. This project will involve installation of conductivity controls on cadmium plating lines to assess water usage before and after utilization of this technology.

The pilot trials described above will be conducted over a 2 year period at a variety of metal finishing facilities. Evaluations of the various technologies' advantages (cost effectiveness, compliance effects, waste reduction, etc.), complexity, compatibility, trialability, and observability will be addressed during the projects. Particular emphasis will be placed on the technical and economical feasibility of the technologies evaluated. WMRC will assist participating companies who are interested in permanent adoption of the technologies through all stages of implementation.

Step 4: Conduct Demonstrations - Each of the 5 mentor facilities that have agreed to participate in this project have also agreed to allow their facilities to be used as demonstration sites whereby representatives from other companies can come to the demonstration sites to see first-hand how the innovations have been successfully implemented.

Demonstrations of technologies that are adopted by mentor facilities as a result of the pilot trials, as well as, innovative practices identified during the assessment phase will be made available to the entire population of metal finishers. The availability of demonstrations will be advertised in the CMFI newsletter, the MWRDGC newsletter, and other appropriate sources. The actual demonstrations will be coordinated by representatives from WMRC. Metal finishers that are favorably impressed by the demonstrations will be encouraged to pursue a pilot trial of the technology at their own facility.

Step 5: Develop Case Studies - In an effort to increase awareness regarding the successful application of technologies evaluated during this project, detailed case studies will be developed. These case studies will carefully explain the results of the pilot trials, applications that the technology can be use in, and economic benefits that can be expected from its use. These case studies will be distributed to a variety of technical assistance providers, such as: U.S. EPA, Illinois EPA, and DCCA. The technical assistance providers will be encouraged to distribute the case studies to their constituents and encourage those who express interest in the technology to contact WMRC to arrange a demonstration of the technology.

Step 6: Train Consultants and Vendors regarding technical and economic aspects of the technologies evaluated in this project and develop protocols for conducting pilot trials. The ADOP2T model was specifically designed to address market failure associated with the diffusion of P2 technologies. It is anticipated that once the opinion leader "mentor" facilities have adopted the technologies evaluated in this project, diffusion to the remaining masses should proceed relatively quickly through conventional means. Therefore WMRC will develop a training program for vendors and consultants that will facilitate rapid diffusion of the innovations. Additionally, WMRC will develop a detailed set of protocols for assisting vendors and consultants in their efforts to conduct pilot trials of the technologies at metal finishing facilities. Two training seminars will be offered to consultants, vendors and other interested parties that explain the results of previous pilot trials, the technical and economic principles associated with the technologies, and appropriate protocols for conducting pilot trials. A manual will be provide to all participants who take advantage of this training opportunity.

Step 7: Provide implementation assistance regarding technical and economic issues with respect to technology adoption. As the various vendors and consultants proceed with efforts to diffuse the innovations to the metal finishing sector, WMRC engineers will provide technical assistance with respect to evaluating equipment performance, trouble-shooting problems and performing total cost accounting of specific applications. Additionally, WMRC will work with the Department of Commerce and Community Affairs, the Small Business Administration and a variety of financial institutions to develop access to capital required for implementing the technologies. Preliminary meetings held with these institutions regarding this project suggest that they are very interested in participating, particularly since the screening process associated with the technologies will be very thorough and, consequently, risk associated with loaning funds for these projects will be minimized.

While many information resources are currently available that describe the advantages of various P2 technologies, the adoption rate of these technologies continues to proceed at a disappointingly slow rate. Execution of this project will substantially improve the diffusion of innovative P2 practices that reduce cadmium emissions in the metal finishing sector.

These efforts will address the deficiencies that are common in other P2 technical assistance models. This project will use a sequential process of identifying best practices and executing brief demonstrations and extended pilot trials of the practices that provide the site-specific information required to influence companies' decisions to adopt. The key to this model's success will center on providing "how-to" assistance required for successful implementation. It is anticipated that the model will have broad application with respect to many P2 technologies in a variety of industrial sectors. It is anticipated that these efforts will result in a model that can be effectively used with other P2 technologies in other sectors.

A comprehensive report that describes all of the various efforts undertaken during the course of this project will be compiled and provided. Results of the individual pilot trial case studies will be presented.

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**Project Milestones:****Dates:**

Detailed assessments completed	12/2000
Complete testing protocol development	03/2001
Complete pilot trials	12/2001
Complete technology demonstrations	06/2002
Complete case studies	07/2002
Train consultants and vendors	08/2002
Complete implementation assistance	08/2002
Submit final project report	08/2002

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☒ Project Addresses Environmental Justice

**If So, Description of How:**

Most metal finishing facilities exist in under-privileged neighborhoods and pollution from these facilities can result in reduced quality of life for the residents in these neighborhoods. Additionally, many metal finishing facilities employ a relatively high concentration of minority workers. Therefore, efforts to reduce pollution from these facilities will improve the quality of life in these areas.

☒ Project Addresses Education/Outreach

**If So, Description of How:**

The demonstrations and pilot trials to be conducted in this project will provide hands-on education for the potential adopters of the technologies to be evaluated. Additionally, fact sheets and case studies will be developed and distributed to other potential adopters of the technologies. Training will be offered to consultants and vendors interested in learning more about the technologies.

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**Project Budget:**

	<b>Federal Share Requested (\$)</b>	<b>Applicant's Share (\$)</b>
<b>Personnel:</b>	97,500	5,356
<b>Fringe:</b>	21,489	1,180
<b>Travel:</b>	2,000	0
<b>Equipment:</b>	0	0
<b>Supplies:</b>	1,200	0
<b>Contracts:</b>	0	0
<b>Construction:</b>	0	0
<b>Other:</b>	2,000	0
<b>Total Direct Costs:</b>	124,189	6,536
<b>Indirect Costs:</b>	30,923	1,628
<b>Total:</b>	155,112	8,164
<b>Projected Income:</b>	0	0

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**Funding by Other Organizations (Names, Amounts, Description of Commitments):**

There are at least 9 technologies identified by metal finishers that they would like demonstrated. \$30,000 in funding has been committed by the Illinois Department of Commerce and Community Affairs to partially fund this effort. In addition, WRMC has committed \$25,000 to develop one of the technologies. The GLNPO funding will provide enough resources so that all 9 technologies can be addressed.

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**Description of Collaboration/Community Based Support:**

This project will be actively supported by the Metropolitan Water Reclamation District of Greater Chicago, the Illinois Department of Commerce and Community Affairs, the U.S. Small Business Administration, the Illinois EPA, the Illinois Department of Natural Resources, and the Chicago Metal Finisher's Institute. Letters of support from these entities can be provided upon request.